

We claim:

1. A circuit for use in an external unit that generates a defibrillation pulse in a defibrillation mode and a pacing pulse in a pacing mode, the circuit comprising:

an energy storage capacitor having a first electrode and a second electrode;

a charging circuit coupled to the energy storage capacitor, wherein the charging circuit is configured to charge the energy storage capacitor;

an energy transfer circuit coupled to the energy storage capacitor, the Energy transfer having a first output lead and a second output lead, wherein the energy transfer is configured to selectively electrically couple the first and second electrodes of the energy storage capacitor to the first and second output leads; and

a control circuit coupled to the charging circuit and the energy transfer circuit, wherein the control circuit is configured to cause the charging circuit to charge the energy storage capacitor to a predetermined level and, when the energy storage capacitor is charged, to control the energy transfer circuit to couple the first and second electrodes of the energy storage capacitor to the first and second output leads of the energy transfer circuit so that the energy transfer circuit provides:

    during the defibrillation mode, a defibrillation pulse at the first and second output leads using energy stored in the energy storage capacitor, and

    during the pacing mode, a pacing pulse at the first and second output leads using energy stored in the energy storage capacitor.

2. The circuit of Claim 1 wherein the energy transfer circuit comprises four legs, a first leg of the energy transfer circuit including a first IGBT switch circuit and a second, a third and fourth leg of the energy transfer circuit each including an SCR switch circuit.

3. The circuit of Claim 2 wherein the energy transfer circuit comprises a bypass circuit, the bypass circuit being coupled in parallel with the third leg of the energy transfer circuit, and wherein the bypass circuit is configured to provide a conductive path that bypasses the third leg of the energy transfer circuit during the pacing mode and is configured to open circuit the conductive path during the defibrillation mode.

4. The circuit of Claim 3 wherein the defibrillation pulse is selectively provided as a biphasic pulse and the pacing pulse is provided as a monophasic pulse.

5. The circuit of Claim 3 wherein, during the pacing mode, the control circuit is configured to determine the predetermined level in charging the energy storage capacitor to achieve a predetermined current level for a subsequently provided pacing pulse.

6. The circuit of Claim 2 wherein the H-bride circuit comprises a current source circuit, the current source circuit being coupled in parallel with the third leg of the energy transfer circuit, and wherein the current source circuit is configured to provide a configurable current to the first output lead during the pacing mode and is configured to provide essentially no current to the first output lead during the defibrillation mode.

7. The circuit of Claim 6 wherein, during the pacing mode, the control circuit is configured to cause the current source circuit to provide the configurable current with a predetermined current level.

8. The circuit of Claim 6 wherein the current source circuit comprises an IGBT and a resistor.

9. The circuit of Claim 1 wherein the energy transfer circuit comprises four legs, a first leg and a second leg of the energy transfer circuit each including an IGBT switch circuit, and a third leg and a fourth leg of the energy transfer circuit each including an SCR switch circuit.

10. The circuit of Claim 9 wherein the H-bride circuit comprises a bypass circuit, the bypass circuit being coupled in parallel with the third leg of the energy transfer circuit, and wherein the bypass circuit is configured to provide a conductive path that bypasses the third leg of the energy transfer circuit during the pacing mode and is configured to open circuit the conductive path during the defibrillation mode.

11. The circuit of Claim 10 wherein the defibrillation pulse is selectively provided as a biphasic pulse having a first phase with a first polarity and a second phase of a second polarity, and wherein the pacing pulse is provided as a monophasic pulse with the second polarity.

12. The circuit of Claim 11 wherein, during the pacing mode, the control circuit is configured to determine the predetermined level in charging the energy

storage capacitor to achieve a predetermined current level for a subsequently provided pacing pulse.

13. The circuit of Claim 9 wherein the H-bride circuit comprises a current source circuit, the current source circuit being coupled in parallel with the third leg of the energy transfer circuit, and wherein the current source circuit is configured to provide a configurable current to the first output lead during the pacing mode and is configured to provide essentially no current to the first output lead during the defibrillation mode.

14. The circuit of Claim 13 wherein, during the pacing mode, the control circuit is configured to cause the current source circuit to provide the configurable current with a predetermined current level.

15. The circuit of Claim 13 wherein the current source circuit comprises an IGBT and a resistor.

16. The circuit of Claim 1 wherein the energy transfer circuit comprises four legs, each of the four legs of the energy transfer circuit including an IGBT switch circuit.

17. The circuit of Claim 16 wherein the defibrillation and pacing pulses are selectively provided as a biphasic pulse or monophasic pulse.

18. The circuit of Claim 17 wherein the defibrillation pulse is a biphasic pulse having a first phase with a first polarity and a second phase of a second polarity, and wherein the pacing pulse is a monophasic pulse with the second polarity.

19. The circuit of Claim 17 wherein the defibrillation pulse is a biphasic pulse having a first phase with a first polarity and a second phase of a second polarity and the pacing pulse is a biphasic pulse having a first phase of the second polarity and a second phase of the first polarity.

20. The circuit of Claim 16 wherein, during the pacing mode, the control circuit is configured to determine the predetermined level in charging the energy storage capacitor to achieve a predetermined current level for a subsequently provided pacing pulse.

21. The circuit of Claim 16 wherein the H-bride circuit comprises a current sense circuit coupled to the energy storage capacitor and the control circuit, and wherein the current sense circuit is configured to detect a current level of current provided by the energy storage capacitor when the circuit is providing a pacing pulse.

22. The circuit of Claim 21 wherein, during the pacing mode, the control circuit is configured to cause the third and fourth legs of the energy transfer circuit to conduct a predetermined level of current when the circuit is providing a pacing pulse.

23. The circuit of Claim 13 wherein the current sense circuit comprises an amplifier, a transformer and a resistor.

24. A method of externally providing a defibrillation pulse or a pacing pulse to a patient from a single unit, the method comprising:

charging an energy storage capacitor;

during a defibrillation mode, transferring energy from the energy storage capacitor to the patient in a defibrillation pulse; and

during a pacing mode, transferring energy from the energy storage capacitor to the patient in a pacing pulse.

25. The method of Claim 24 wherein an energy transfer circuit is used to transfer energy from the energy storage capacitor to the patient in both the defibrillation and pacing modes.

26. The method of Claim 24 wherein the energy storage capacitor is charged to a predetermined level so that the pacing pulse has a current of a predetermined level.

27. The method of Claim 24 wherein the pacing pulse is a biphasic pulse.

28. An apparatus for externally providing to a patient a defibrillation pulse during a defibrillation mode and a pacing pulse during a pacing mode, the apparatus comprising:

an energy storage capacitor;

charging means for charging the energy storage capacitor;

switch means, coupled to the energy storage capacitor, for selectively transferring energy from the energy storage capacitor to the patient; and

control means for causing the switch means to transfer energy from the energy storage capacitor to the patient in a defibrillation pulse during the defibrillation mode, and for transferring energy from the energy storage capacitor to the patient in a pacing pulse during the pacing mode.

29. The apparatus of Claim 28 wherein the switch means comprises an energy transfer circuit, wherein the energy transfer circuit is selectively configurable to transfer energy from the energy storage capacitor to the patient in both the defibrillation and pacing modes.

30. The apparatus of Claim 28 wherein the control means is configured to cause the charging means to charge the energy storage capacitor to a predetermined level wherein the pacing pulse has a current of a predetermined level.

31. The apparatus of Claim 28 wherein the pacing pulse is a biphasic pulse.